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HEAT PIPE TECHNOLOGY
A BIBLIOGRAPHY WITH ABSTRACTS

QUARTERLY UPDATE MARCH 31, 1977

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TECHNOLOGY APPLICATION CENTER
THE UNIVERSITY OF NEW MEXICO
ALBUQUERQUE, NEW MEXICO 87131

HEAT PIPE TECHNOLOGY
A BIBLIOGRAPHY WITH ABSTRACTS

QUARTERLY UPDATE
JANUARY-MARCH 1977

ASSEMBLED BY
THE HEAT PIPE INFORMATION OFFICE
OF
THE TECHNOLOGY APPLICATION CENTER
INSTITUTE FOR APPLIED RESEARCH SERVICES
THE UNIVERSITY OF NEW MEXICO
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PREFACE

Heat Pipe Technology is a continuing bibliographic summary of research on heat pipes. The first volume was published in the Spring of 1971 and is cumulative through March of that year. The 1971, 1972, 1973 and 1974 Annual Supplements as well as the 1975 and 1976 Quarterly Update Series have been published and distributed. Additional copies are available from the Technology Application Center.

This update to Heat Pipe Technology cites the additional references identified during January, February and March of 1977. It is the first of the 1977 quarterly series intended to provide "current awareness" to heat pipe researchers.

A library containing essentially all of the articles and publications referenced in this update, and in all the previous volumes is maintained at TAC. Although a considerable effort has been made to insure that the bibliography is complete, readers are encouraged to bring any omissions to the attention of this office.

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GUIDE TO USE OF THIS PUBLICATION

A number of features have been incorporated to help the reader use this document. They consist of:

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I. GENERAL INFORMATION, REVIEWS, SURVEYS

HP77 10000 HEAT TRANSFER - A REVIEW OF 1975 LITERATURE

Eckert, E.R.G., Sparrow, E.M., Goldstein, R.J., Scott, C.J., Pfender, E., Patankar, S.V., Ramsey, J.W., (University of Minnesota, Minneapolis, MN), International Journal of Heat and Mass Transfer, V 19:1217-1243, Nov 1976
 Avail:TAC

The paper surveys results that have been published in various fields of heat transfer during 1975. Brief summaries of the basic result of several hundred individual papers on the following topics are given conduction, channel flow, boundary-layer and external flows, flow with separated regions, transfer mechanisms, natural convection, convection from rotating surfaces, combined heat and mass transfer, change of phase, radiation in participating media, surface radiation, liquid metals, measurement techniques, heat exchange and heat pipes, aircraft and space vehicles, solar energy, general heat-transfer applications, and plasma heat transfer.

(CONDUCTION, CONVECTION, BOUNDARY-LAYER, MASS-TRANSFER, PHASE-CHANGE, RADIATION, MEASUREMENT-TECHNIQUES, LIQUID-METALS, SOLAR-ENERGY, PLASMA)

HP77 10001 HEAT PIPE - A SURVEY

Scullion, J., (Henry J. Kaiser Co., Ltd., Montreal, Quebec, Canada), ASME paper 76-DET-84
 Avail:TAC

This paper examines some of the work that has been done in developing the heat pipe. The paper is divided into six parts: history, basic operating principles, research and experimentation to measure and proposed empirical flow and heat transfer equations, research and development of materials, applications to contemporary problems, and proposals of systems that could be used to solve everyday problems using easily found materials.

(HISTORY, OPERATION, RESEARCH, APPLICATIONS)

II. HEAT PIPE APPLICATIONS

II. A. GENERAL APPLICATIONS

HP77 20000 THERMAL ENERGY STORAGE UNIT BASED ON LITHIUM FLUORIDE

Asselman, G.A.A., (Philips' Research Laboratories, Eindhoven, Netherlands), Energy Conversion, V 16:35-47, N1-2, 1976
 Avail:TAC

A thermal energy storage unit employing lithium fluoride has been built to a Stirling engine. The heat transport from the electric heating elements to the heat storage unit and from the latter to the heat sink is affected by the evaporation and condensation of sodium. The liquid sodium is transported with the aid of capillary structures, so that the system of heat transfer has the characteristics of a heat pipe. The experience gained with the storage unit built combined with later developments in the heat-pipe field and in the use of anti-corrosion inhibitors for the salt, have led to more sophisticated designs, which are described.

(STIRLING-CYCLE, DESIGN, ANTI-CORROSION- INHIBITORS)

HP77 20001 THE USE OF A HEAT PIPE FOR THE CONTROL AND CALIBRATION OF THERMAL RADIATION METERS

Lanza, F., Ricolfi, T., (Ist. Metrol. 'G. Colonnitti', Turin, Italy), Termotecnica, V 30: 184-187, N4, 1976, In Italian

A thermal radiation source with good blackbody characteristics is described. It consists of a conventional tubular oven containing an inconel heat pipe with Na as the working fluid. Data are reported on temperature uniformity, emissivity, and angular distribution of radiation. Applications for controlling and calibrating optical pyrometers, radiometers, and similar instruments are examined.

(OVEN, INCONEL, SODIUM)

HP77 20002 A HEAT PIPE DEVICE FOR THERMOMETRIC PURPOSES BETWEEN 600°C AND 1100°C

Lanza, F., Ricolfi, T., Bassani, C., Geiger, F., (Ist. Metrol. 'G. Colonnitti', Turin, Italy), Journal of Physics, E, V 9:876-878, N10, 1976
 Avail:TAC

A furnace was developed which embodies a heat pipe that operates at 600-1100°C. The design data of the heat pipe and the results of different tests on its effectiveness in providing large isothermal regions are reported. Thermometric applications stemming from the test results are suggested.

(FURNACE, DESIGN)

HP77 20003 HEAT-PIPE-OVEN REACTOR (HPOR) STUDIES. II - FORMATION OF EXCITED CN IN THE LI-NF₃-CCl₄ TERNARY FLAME SYSTEM

Luria, M., Eckstrom, D.J., Benson, S.W., (Stanford Research Institute, Menlo Park, CA), Journal of Chemical Physics, V 65:1595-1596, Aug 15, 1976
 Avail:TAC

This paper reports the first observation of purely chemical production of electronically excited CN molecules from the NF₃-CCl₄-Li ternary flame system for chemical laser applications.

(CHEMICAL-LASER, CYANIDES, LITHIUM COMPOUNDS)

HP77 20004 HEAT-PIPE-OVEN REACTOR STUDIES. III - CHEMILUMINESCENCE FROM TERNARY FLAME SYSTEMS

Luria, M., Eckstrom, D.J., Benson, S.W., (Stanford Research Institute, Menlo Park, CA), Journal of Chemical Physics, V 65:1581-1588, Aug 15, 1976
 Avail:TAC

The paper presents results of an experimental study of chemiluminescence from several ternary flame systems (volatile polyhalide, alkali metal, and oxidizer) performed in a heat pipe-oven reactor. The following polyhalides were investigated: CCl₄, GeCl₄, SiCl₄, SnCl₄, PCl₃, BI₃, AsCl₃, SCl₂ and NF₃, with sodium vapor used for the reduction and N₂O for the oxidation. The emission characteristics of these ternary flame systems were classified into three groups (1) flames that produced emission from electronically excited diatomic species, (2) flames that produced strong emission from the various electronic levels of the alkali atoms up to the ionization limit, but no radiation from oxides, and (3) weak flames that produced emission only from the lowest resonance level of sodium. The photon yields in the first group were on the order of 10 to the -2nd to 10 to the -4th; in the second group, up to 3% and in the third group, less than 10 to the -6th.

(CHEMICAL LASER, ALKALI METALS, OXIDIZERS, PHOTON-DENSITY)

HP77 20005 WHAT'S NEW IN HEAT TRANSFER EQUIPMENT

Murray, I., (Applied Heat Transfer Division, National Engineering Laboratory, England),
Process Engineering, p. 68,69,71, Nov 1975
Avail:TAC

The author introduces an ultrasonically cleaned cooler, a falling film evaporator, a sludge heat exchanger, applications for heat pipes, and a design service for shell-and-tube heat exchangers based on computer programs.

(COOLER, FALLING-FILM-EVAPORATOR, HEAT EXCHANGERS)

HP77 20006 CONTROLLING POLYMER TEMPERATURE OF A FIBER SPINNING PROCESS USING VARIABLE CONDUCTANCE HEAT PIPES

Sun, T.H., (Hughes Aircraft Co., Torrance, CA), Schaeffer, J.I., (Brunswick Corp., Cedar Knolls, NJ), No. 31, American Institute of Chemical Engineers, 16th National Heat Transfer Conference, St. Louis, MO, Aug 8-11, 1976
Avail:TAC

In current polymer fiber spinning processes, prefilters are used to eliminate the bulk of the contaminants prior to entering the spin pump. However, when the contaminants gradually build up in the filter, the pressure drop across the filter increases, causing the temperature of the polymer to be increased due to the additional friction. When the system is switched to a clean filter, the pressure drop decreases, and the polymer flows at a lower temperature. The variation of polymer temperatures that occurs because of the filter switching affects fiber spinning parameters. In order to solve these non-uniform polymer temperature problems, the use of variable conductance heat pipe (VCHP) was considered the Dowtherm A heat pipe design and test results are presented.

(CONTAMINANTS, FILTER)

HP77 20007 A TERRESTRIAL SOLAR ENERGY POWER SYSTEM

Tani, T., Sawata, S., Horigome, T., (Electrotechnical Laboratory, Tokyo, Japan), Solar Energy, V 18:281-285, N4, 1976
Avail:TAC

Development of an effective solar energy utilization technique is of prime importance in solving the energy crisis mankind is confronted with today. In recent years advancements have been made in high temperature measurements, high efficiency selective radiation materials, high temperature heat pipes, heat storage medium, semiconductor manufacturing techniques, space technology, etc.. In this article the authors outline a solar energy utilization system (a terrestrial solar energy power system) and discuss the feasibility of a solar energy power system.

(EFFICIENCY, ENERGY-STORAGE, TESTS, HYDROGEN, MATERIALS, RADIATION, SEMICONDUCTORS, SOLAR-COLLECTORS)

HP77 20008 HEAT PIPES FOR THE TRANS-ALASKA PIPELINE

Waters, E.D., (McDonnell Douglas Astronautics Co.), Paper No. 119, presented at the 2nd International Heat Pipe Conference at Bologna, Italy, Mar 31-Apr 2, 1976
Avail:TAC

The reason for cooling the support members of the above-ground portion of the trans-Alaska pipeline is discussed, along with studies that led to use of heat pipes for seasonal refrigeration of the permafrost. The physical and thermal characteristics of the heat pipes, which range from 9 to 23 meters in length, are described. Manufacturing approaches to producing such pipes at rates of more than 500 units per day are discussed. Results of heat pipe installation in a segment of the pipeline during late 1974 and early 1975 are presented.

(PERMAFROST, MANUFACTURE, INSTALLATION)

HP77 20009 FUEL-SAVING DEVICES FOR THE HOME

Consumer Reports, p. 16-17, Jan 1977
Avail:TAC

This report briefly introduces two devices to save fuel for home owners: a CO2 indicator to increase the combustion efficiency of gas-fired furnaces; an Air-O-Space Heater by Isothermics, Inc., to recover the heat from the flue gas.

(COMBUSTION-EFFICIENCY, FURNACES, HEAT-PIPE-HEATER, FLUE-GAS)

II. B. THERMIONIC AND THERMOELECTRIC CONVERTERS

II. C. AEROSPACE ORIENTED APPLICATIONS

HP77 22000 INVESTIGATION OF THE THERMAL CONTROL OF INSTRUMENTS MOUNTED IN THE SPACE SHUTTLE CARGO BAY

Bartoszek, J.T., Almgren, D.W., (Arthur D. Little, Inc., Cambridge, MA), Ollendorf, S., Coyle, M., (NASA, Goddard Space Flight Center, Greenbelt, MD), AIAA paper 76-461, 11 p., American Institute of Aeronautics and Astronautics, Thermophysics Conference, 11th, San Diego, CA, July 14-16, 1976
 Avail:TAC

Results are presented for an investigation intended to examine the orbital averaged thermal response of a number of instruments, each being representative of a class of scientific instrumentation, when they are individually mounted on pallets and operated in the cargo bay of the shuttle. The discussion covers mainly the shuttle orbiter thermal models, the solar viewing instrument, and the high-energy instrument. One approach to thermal insulation of smaller instruments is to provide a thermal canister insulated from the cargo bay and equipped with variable conductance heat pipes. Two approaches are proposed for larger instruments. One approach is to provide a thermal curtain across the top of the pallet which shields the pallet cavity from direct sunlight, while the second approach is to provide a fluid system to transfer heat from a specified location on an instrument to either a space viewing radiator on the pallet or instrument or the orbiter cooling system. These thermal control design concepts represent several ideas for standard reusable thermal control systems.

(SATELLITE, INSULATION, HEAT-SHIELD)

HP77 22001 EXTENDED CRYOGENIC PERFORMANCE OF LOBAR WICK HEAT PIPE/RADIATOR

Cenkner, A.A., Jr., Nelson, B.E., Petrie, W., (Perkin-Elmer Corp., Danbury, CT), Paper No B1, presented at the 2nd International Heat Pipe Conference at Bologna, Italy, Mar 31-Apr 2, 1976

Avail:TAC

Two series of cryogenic-vacuum tests were performed by Perkin-Elmer as part of a continuing research program aimed at developing lightweight, reliable, and efficient Lobar Wick heat pipe/radiator or heat pipe/solid cryogen cooling systems for earth resource and meteorological space-borne detectors. In the first series, a 640 cm long nitrogen heat pipe/radiator was tested from 74-116°K; pipe performance was isothermal to approximately 1°K. During the second, a thermal evaluation was made on the feasibility of converting a complex focal plane assembly into an integral part of a heat pipe cooling system. High power localized heating was applied along the 1.3 cm wide lip of an arc-shaped evaporator that was 42.4 cm long and 7.6 x 10.24 cm² in cross gradients, with $\pm 1^\circ\text{K}$ temporal stability during transient loadings, can be achieved with power levels up to 20 watts. While no attempt was made to identify the upper heat transport limit of the Lobar Wick, 31.3 watts was successfully carried by nitrogen.

(TESTS, COOLING-SYSTEM, HEAT-TRANSPORT-LIMIT)

HP77 22002 HEAT PIPE AND SPACE RADIATOR DEVELOPMENTS

Goodacre, J.B., (GEC - Marconi Electronics, Chelmsford, United Kingdom), Griffiths, G.D., (Marconi Space and Defense Systems Ltd., Portsmouth, United Kingdom), Paper No. K6, presented at the 2nd International Heat Pipe Conference at Bologna, Italy, Mar 31-Apr 2, 1976

Avail:TAC

A number of test rigs have been developed and manufactured under a U.K. government contract involving a comprehensive survey of wick types for space applications. These rigs comprise wicking rise and falling column techniques for capillary head measurements and a combined rig for measuring the permeability of wick samples under both forced and gravity flow conditions. These rigs have been utilized to determine the wicking properties of meshes, sintered powders and metal felts. The artery heat pipe manufacture and its computer aided design are discussed. Since weight is of critical importance in spacecraft design, a study is now being carried out into the use of fixed conductance heat pipes instead of solid conduction to distribute this heat over the radiator surface. The design criteria of this radiator is presented.

(WICKING-PROPERTIES, DESIGN, ARTERY-HEAT-PIPE)

HP77 22003 DEVELOPMENT OF SPACE APPLICATIONS OF HEAT PIPES AT AEROSPATIALE

Martinez, I., Moschetti, B., (Aerospatiale, Cannes, France), Mathieu, J.P., (Sabca, Bruxelles, Belgique), Paper No. K3, presented at the 2nd International Heat Pipe Conference at Bologna, Italy, Mar 31-Apr 2, 1976

Avail:TAC

The overall programme has been split into two major steps: first step: 1972 through 1974: Development and application of conventional heat pipes and of relevant applications, second step: 1975 through 1976: Development and qualification of variable-conductance heat pipes and of relevant applications. The various heat pipes developed and proven at SABCA, permit to cover a wide range of heat transfers. The calculation methods for systems including heat pipes have been developed and confirmed by the numerous tests performed at both levels

of conventional heat pipes systems and gas heat pipes systems. A wide choice of proven technological solutions is from now on available and is easily transferrable according to which respective cases are envisaged.

(VCHP, APPLICATIONS)

HP77 22004 THE INTERNATIONAL HEAT PIPE EXPERIMENT

McIntosh, R., Ollendorf, S., Sherman, A., (NASA Goddard Space Flight Center, Greenbelt, MD), Harwell, W., (Grumman Aerospace Corp., Bethpage, NY), paper No. J1, presented at the 2nd International Heat Pipe Conference at Bologna, Italy, Mar 31-Apr 2, 1976
Avail:TAC

On October 4, 1974, the International Heat Pipe Experiment was launched aboard a Black Brant sounding rocket from White Sands, New Mexico. The flight provided six minutes of near zero gravity during which a total of ten separate heat pipe experiments were performed. The fifteen heat pipes tested represent some of the latest American and European technology. This flight provided the first reported zero gravity data on cryogenic and flat plate vapor chamber heat pipes. Additionally, valuable design and engineering data was obtained on several other heat pipe configurations. This paper will discuss the payload and several of its experiments.

(ZERO-GRAVITY, CRYOGENIC-TEMPERATURE, VAPOR CHAMBER)

HP77 22005 A HEAT PIPE PANEL FOR A HIGH POWER SPACEBORNE TRANSPONDER

Scollon, T.R., (General Electric Co., Philadelphia, PA), DOC-76SDS030, 89 p., July 1976, N76-31452
Avail:TAC

The development, design, and testing are described of a heat pipe isothermalizing panel which can provide primary thermal control for a high-power spaceborne transponder. A panel of this design is suitable for use in a two-channel color television transponder which is the payload of a communications satellite. The heat pipe panel project was successful with respect to all defined objectives. A panel was designed and fabricated and demonstrated, through extensive testing, the ability to meet all imposed thermal requirements.

(DESIGN, TEST, COMMUNICATIONS-SATELLITE)

II. D. NUCLEAR SYSTEMS

HP77 23000 CONCENTRIC HEAT PIPE CAVITY FOR E-BEAM EXCITED LASERS

Haller, F.B., (National Bureau of Standards, Boulder, CO), Hessel, M.M., Neef, W., Lai, W., Lohr, H., Symposium on Engineering Problems of Fusion Research, 6th, Proceedings, San Diego, CA, p. 79-83, Nov 18-21, 1975
Avail:TAC

A concentric heat pipe oven for metal vapor-noble gas mixtures has been designed and constructed as a high power laser cavity for laser fusion applications. A 1 MeV, 100 KA, 50 ns e-beam is injected into this oven through a stainless steel foil window, .125 mm thick. Details of the construction and design considerations of the heat pipe oven, foil window and safety features are given.

(OVEN, FUSION, DESIGN)

HP77 23001 HEAT PIPES WITH A NON-CONDENSABLE GAS AND THEIR APPLICATION IN NUCLEAR APPARATUS AND INSTRUMENTS

Polasek, F., Stulc, P., (National Research Institute for Machine Design, Prague - Bechovice, Czechoslovakia), paper No. I7, presented at the 2nd International Heat Pipe Conference at Bologna, Italy, Mar 31-Apr 2, 1976
Avail:TAC

The heat pipes filled with active fluid and inert gas can be advantageously applied in the nuclear apparatus and instruments which require the maintaining of the heat exchanging surface temperature within a narrow temperature range at a change in the heat flux. Results of the operating characteristic measurements of the stainless steel heat pipes filled with H₂O + Ar and Na + Ar are given in this contribution. The stabilizing heat pipes were used as heat exchanging elements in irradiation capsule prototypes for structural materials testing in the nuclear reactor active zone and in the vacuum distilling unit of 100 l crude sodium capacity.

(STAINLESS STEEL, WATER, SODIUM, IRRADIATION-CAPSULE)

II. E. ELECTRICAL AND ELECTRONIC APPLICATIONS

HP77 24000 HIGH POWER MICROWAVE WINDOW WITH A MICROWAVE TRANSPARENT COOLING MECHANISM

Smith, B.L., (U.S. Army, Huntsville, AL), Colwell, G.T., Basset, H.L., Schuchardt, J.M., (Georgia Institute of Technology, Atlanta, GA), In: International Conference of Electromagnetic Windows, 3rd, Ecole Nationale Supérieure de Techniques Avancées, Paris, France, Proceedings, Sept 10-12, 1975, A76-45683

The paper describes a microwave transparent heat pipe technique for cooling microwave devices. A capillary material called the wick is bonded to the inner surface of a metal pipe. The pipe is evacuated: a suitable working fluid is used to saturate the wick; the device is sealed. One end of pipe is heated, while the other end is cooled. Fluid will evaporate from the heated region, with the resulting vapor travelling to the cooled region where it condenses. By capillary action, the wick transports the condensed fluid back to the heated area and the cycle repeats itself. The cooling technique was tested on an S-band microwave window, up to 435 watts heat flux.

(TEST, HEAT FLUX)

III. HEAT PIPE THEORY

II. A. GENERAL THEORY

HP77 30000 INVESTIGATION OF GAS-CONTROLLED HEAT PIPES WITH RESERVOIRS OF CONSTANT AND VARIABLE VOLUME

Barsukov, V.V., (Odesskii Tekhnologicheskii Institut Kholodilnoi Promyshlennosti, Odessa, Ukrainian, USSR), Inzhenerno-Fizicheskii Zhurnal, V 31:587-593, Oct 1976, A77-14327, In Russian

The performance characteristics of gas-controlled heat pipes is analyzed for pronounced fluctuations of the temperatures of the heat release area and the medium about the reservoir. An expression which can be used to evaluate the possibility of using a heat pipe with a hot reservoir of constant volume under various conditions is derived, along with an equation for calculating heat pipes with a reservoir of variable volume.

(PERFORMANCE, THEORIES)

HP77 30001 TRANSFER FUNCTION ANALYSIS OF HEAT PIPES

Rajakumar, A., Krishnaswamy, P.R., (Chemical Engineering, Indian Institute of Technology, Madras, India), paper No. D6, presented at the 2nd International Heat Pipe Conference at Bologna, Italy, Mar 31-Apr 2, 1976
Avail:TAC

This paper describes the dynamic characteristics of heat pipes in terms of frequency response through an unsteady-state model. Detailed frequency domain dynamics of heat pipes has been established quantitatively. The response curves are definitive in differentiating and describing the effects of system parameters on the dynamics. Preliminary experimental investigation carried out in the laboratory indicates that experimental transfer functions agree with theory. Apart from describing the dynamics, the results could be readily used in feedback control of heat pipes.

(FREQUENCY-RESPONSE, FEEDBACK-CONTROL)

HP77 30002 GAS RELEASE DURING LONG-TERM OPERATION OF HEAT PIPES

Gil, V.V., Minkovich, E.N., Shnyrev, A.D., (Akademiia Nauk Belorusskoi SSR, Institut Teplo-i Massoobmena, Minsk, Belorussian, USSR), Inzhenerno-Fizicheskii Zhurnal, V 31:594-600, Oct 1976, A77-14328, In Russian

Gassing processes are analyzed for low-temperature heat pipes employing hydrogen-containing heat transfer agents. The influence of noncondensing gases on the service life of low-temperature heat pipes is examined. It is shown that the mass of the released gas is defined by thermal dissociation, chemical dissolution, and electrochemical dissociation, the latter usually playing the principal part. A method of calculating gassing is developed on the basis of theoretical considerations.

(THERMAL-DISSOCIATION, CHEMICAL-DISSOLUTION, THEORIES)

II. B. HEAT TRANSFER

HP77 31000 INVESTIGATION OF HEAT TRANSFER CAPILLARY LIMIT IN SODIUM HEAT PIPES

Ivanovsky, M.N., Subbotin, V.I., Sorokin, V.P., Yagodkin, I.V., Tchulkov, B.A., Kuznetsova, L.M., (Institute of Physics and Power Engineering, Obninsk, USSR), paper No. C2, presented at the 2nd International Heat Pipe Conference at Bologna, Italy, Mar 31-Apr 2, 1976
Avail:TAC

Development of engineering methods for the calculation of heat transfer capillary limit and experimental check of application range of such procedures remain urgent at present. For the high-temperature heat pipes it is important to study the region of operating temperatures at which the vapor compressibility can influence the calculational relationships. The results of an experimental check of maximum heat transfer values obtained from numerical calculation procedures with consideration for the vapor compressibility and without it are presented in the paper.

(VAPOR-COMPRESSIBILITY, EXPERIMENTS)

III. C. FLUID FLOW

HP77 32000 STUDY OF THE PROPERTIES OF HEAT PIPES WITH LIQUID-METAL HEAT TRANSFER AGENTS IN LOW-TEMPERATURE REGIMES

Bystrov, P.I., Popov, A.N., Teplofizika Vysokikh Temperatur, V 14:629-637, May-June 1976, A77-13243, In Russian

A method is outlined for the theoretical study of the properties of heat pipes containing liquid-metal heat-transfer agents at low vaporization temperatures. This method takes into account the compressibility and friction of the vapor flow, heat-load nonequilibrium along the length of the vaporization zone, and the temperature dependence of the properties of the heat-transfer agent. It is shown that the capacity of heat pipes in sonic flow regimes depends substantially on the geometric dimensions of the vaporization zone; i.e., the diameter of the vapor duct and the ratio of zone length to diameter. The calculations also indicate that neglect of the friction of the vapor flow leads to errors of 50% or more in determining the sonic limit. The theoretical results are found to be in good agreement with experimental measurements in a vapor duct and with empirical data on the sonic limit of heat transfer. The greatest discrepancy between theory and experiment does not exceed 10%.

(COMPRESSIBILITY, FRICTION, SONIC-LIMIT, THEORY, EXPERIMENT)

HP77 32001 DETERMINATION OF FLOW VARIABLES IN THE EVAPORATOR OF A NONUNIFORMLY-HEATED HEAT PIPE

Tolubinskiy, V.I., Shevchuk, Ye.N., Chistopyanova, N.V., Heat Transfer - Soviet Research, V 7:74-78, N5, Sept-Oct 1975
Avail:TAC

A set of differential equations for determining the pressure, velocity, temperature and density distributions of vapor along a heat-pipe evaporator as a function of heat-flux nonuniformity is derived. The set is convenient for computer solution. Results of numerical solution are presented.

(PRESSURE, VELOCITY, TEMPERATURE, DENSITY, NUMERICAL SOLUTION)

IV. DESIGN, DEVELOPMENT, AND FABRICATION

IV. A. GENERAL

HP77 40000 THERMODYNAMIC ANALYSIS OF ALTERNATE ENERGY CARRIERS: HYDROGEN AND CHEMICAL HEAT PIPES

Cox, K.E., (University of New Mexico, Albuquerque, NM), Carty, R.H., Conger, W.L., Soliman, M.A., Funk, J.E., Hydrogen Energy, V 2:1B.3-1B.16, 1976
 Avail:TAC

Hydrogen and chemical heat pipes have been proposed as methods of transporting energy from a primary energy source (nuclear, solar) to the user. In the chemical heat pipe system, primary energy is transformed into the energy of a reversible chemical reaction; the chemical species can then be transmitted or stored until the energy is required. Chemical heat pipe systems such as EVA-ADAM and Solchem appear more attractive than thermochemical schemes that produce hydrogen by water-splitting on a first-law efficiency basis. Analysis of thermochemical hydrogen schemes and chemical heat pipe systems on a second-law efficiency or available work basis show that hydrogen is superior especially if the end use of the chemical heat pipe is electrical power. Additionally, hydrogen has the further advantage of wider utilization.

(CHEMICAL-REACTION, EFFICIENCY)

HP77 40001 PROCESSES IN HEAT PIPES

Ivanovskii, M.N., Sorokin, V.P., Yagodka, I.V., Tr. Fiz.-Energ. Inst., p. 281-289, 1974, In Russian

The sound, the carry-over, the capillary, and the heating-section limitations that control the efficiency are discussed. The condensation-zone design variations were analyzed. The maximum axial heat flux at 500-2000°K was calculated for K, Na, Li, Ca, Ti, Ba, and Sr working fluids. The maximum transfer capacity was determined experimentally with Na. The heating-section limitations (the evaporation velocity, the reactive forces, and the boiling-over effect) and the negative effect of impurities in the heat-transfer media or in the heat-pipe surface material were pointed out.

(SONIC-LIMIT, ENTRAINMENT-LIMIT, WICKING LIMIT, BOILING-LIMIT, MAXIMUM-CAPACITY)

HP77 40002 FUNDAMENTALS OF HEAT PIPE THEORY AND DESIGN

Levitan, M.M., Perelman, T.L., (Institute of Heat and Mass Transfer, Academy of Sciences of the Belorussian SSR, Minsk, USSR), Soviet Physics - Technical Physics, V 19:983-998, N8, Feb 1975, English translation

The problem of heat pipe design is treated rigorously. Heat and mass transfer in the jacket and cavity of a heat pipe are considered. Coupling conditions at the internal surface of the jacket are analyzed in detail. As applied to high-temperature heat pipes in which alkali metals are used as the heat transfer agent the problem is formulated with the inclusion of chemical transformations of the vapors of those transfer agents. For proper heat pipe optimization operating conditions are set up which include the reaction of the fluids of vaporizing and condensing materials at the phase-transition surface.

(HEAT TRANSFER, MASS TRANSFER, JACKET, ALKALI-METALS, OPTIMIZATION)

HP77 40003 HEAT PIPES FOR THE TEMPERATURE RANGE FROM 200°C TO 600°C

Polasek, F., Stulc, P., (National Research Institute for Machine Design, Prague - Bechovice, Czechoslovakia), paper No. 9, presented at the 2nd International Heat Pipe Conference at Bologna, Italy, Mar 31-Apr 2, 1976
 Avail:TAC

The aim of this paper is to give some knowledge from the research of the heat pipes with working temperatures from 200 to 600 Centigrades with particular angle directed to a finding of a new unconventional working fluid enabling the function of heat pipes within the whole range of temperatures from 200 to 600°C. The first part of the paper deals with the working fluids from the point of view of the thermophysical properties and the second part gives the results of the theoretical and experimental determination of the thermal characteristics of the produced vertical gravity pipe function samples filled with dowerm A, sulphur and sulphur with additives.

(DOWTHERM A, SULPHUR, ADDITIVES)

HP77 40004 ON THE DESIGN OF HEATER SECTIONS OF NATURAL-CONVECTION, LIQUID-METALS HEAT PIPES

Sobrero, E., (Fac di Ing, Bologna, Italy), Energie Nucleaire (Milan), V 23:212-224, N4, Apr 1976, In Italian

Analytical relations for the design of heater sections of natural-convection, liquid-metals heat-pipes are considered, that account for the internal thermal resistance between the walls and the boiling liquid and its variations along the heater section. The comparison between the results obtained by this way in the calculation of the heat exchanger surfaces, and those deriving from simplified hypotheses (for example, assuming as null the thermal resistance between the wall and the boiling liquid) shows a significant difference, in particular as concerns heat exchangers in nuclear power plants using liquid metals as primary coolants. The present approach permits a more realistic calculation of the exchange surfaces.

(THERMAL RESISTANCE, HEAT-EXCHANGERS, LIQUID-METALS)

IV. B. WICKS

HP77 41000 PRIMING FOILS FOR VENTING NONCONDENSABLE GAS FROM HEAT PIPE ARTERIES

Eninger, J.E., (TRW System Group, Redondo Beach, CA), Progress in Astronautics and Aeronautics, V 39:235-243, 1975

Avail:TAC

Noncondensable gas in an arterial heat pipe, whether a contaminant or intentionally introduced for control, results in arterial bubbles during priming which subsequently grow and deprime the artery when a heat load is applied. A method is presented to vent the gas through capillary-size holes in a foil-walled portion of the artery at the evaporator end. Liquid cannot plug these holes because the foil is sized so thin that the menisci on either side of a potential liquid plug would coalesce, and the hole would empty. Theoretical and experimental results are presented which relate the hole size to the required foil thickness.

(BUBBLES, HOLES, MENISCI)

HP77 41001 OPERATION PECULIARITIES OF LOW TEMPERATURE HEAT PIPES WITH CRIMPED CAPILLARY STRUCTURE

Ivanovsky, M.I., Ilyin, Yu.A., Kolgotin, F.F., Korneev, V.I., Privesentsev, V.V., Rybkin, B.I., Serbin, V.I., Sergeev, Yu.Yu., Sidorenko, E.M., Sorokin, V.P., (Institute of Physics and Power Engineering Obninsk, USSR), paper No. B4, presented at the 2nd International Heat Pipe Conference at Bologna, Italy, Mar 31-Apr 2, 1976

Avail:TAC

The capillary structure considered in the report is made of crimped metallic gauze. It can easily be manufactured and allows to provide a sufficiently high heat transfer in the heat pipe. Being non-uniform such structure remains stable under certain conditions at under-filling with coolant. In the report some operational peculiarities of channels of different dimensions have been analysed theoretically and on the basis of experiments with various low-temperature liquids.

(CHANNELS, THEORIES, EXPERIMENTS)

HP77 41002 CAPILLARY-POROUS MATERIALS AND THE TRANSFER OF HEAT OR ENERGY

Luikov, A.V., (deceased), International Chemical Engineering, V 16:54-60, N1, Jan 1976

Avail:TAC

Capillary-porous materials are considered in connection with the transfer of mass and energy in such devices as heat pipes and porous nozzles. Recent research at the Institute of Heat and Mass Transfer of the BSSR Academy of Sciences in this field is summarized. The theory of liquid transfer in capillary-porous materials is outlined, including the effects of the finite rates of mass propagation.

(NOZZLES, MASS-PROPAGATION)

HP77 41003 HEAT TRANSFER IN POROUS SINTERED MATERIALS

Maksimov, Ye.A., Stradomskiy, M.V., Heat Transfer - Soviet Research, V 8:8-12, N1, Jan-Feb 1976

Avail:TAC

The most efficient method for correlation of experimental data on heat transfer in porous sintered materials is selected from a brief survey of literature on this topic and from analysis of flow patterns of coolants in these materials. This method is then used for representing the results on heat transfer in materials consisting of spherical particles, fibers and irregularly shaped particles; the correlating curve agrees with test data with an rms error of $\pm 30\%$.

(PARTICLES, FIBERS, CORRELATION-CURVES)

HP77 41004 A HIGH PERFORMANCE EVAPORATIVE HEAT TRANSFER WICK

Saaski, E.W., Franklin, J.L., (Sigma Research, Inc., Richland, WA), paper No. 30, American Institute of Chemical Engineers, 16th National Heat Transfer Conference, St. Louis, MO, Aug 8-11, 1976
 Avail:TAC

A new wicking concept for efficient thin-film evaporation of fluids is described. With ammonia, heat transfer coefficients in the range of 2 to 2.7 W/cm²°K were measured at heat flux densities up to 20 W/cm² while, with R-11, a heat transfer coefficient of 1.0 W/cm²°K was measured with flux densities up to 5 W/cm². Heat transfer coefficients and flux densities were unusually high compared to literature data for other nonboiling evaporative surfaces, and it is suggested that this enhancement may be either due to film turbulence generated by vapor shear or convective cells driven by surface-tension gradient.

(THIN-FILM-EVAPORATION, AMMONIA, FREON-11, HEAT-TRANSFER-COEFFICIENTS, HEAT-FLUX)

HP77 41005 CAPILLARY ABSORPTION OF HEAT PIPE WICKS

Semena, M.G., Kostornov, A.G., Gershuni, A.N., Moroz, A.L., Zaripov, V.K., Journal Engineering Physics, V 27:1487-1491, N6, Dec 1974, English Translation
 Avail:TAC

The capillary absorption kinetics in metal-fiber wicks for low-temperature heat pipes is investigated. On the basis of the experimental data obtained, the distributions of the impregnation from velocity along the wicks were determined by means of graphic differentiation of the absorption kinetics curves.

(KINETICS, METAL-FIBER, IMPREGNATION-VELOCITY)

HP77 41006 STRUCTURAL HEAT CONDUCTIVITY OF FIBER METAL WICKS FOR HEAT PIPES

Semena, M.G., Kostornov, A.G., Zaripov, V.K., Moroz, A.L., Shevchuk, M.S., (Kievskii Politekhnikskii Institut; Akademiia Nauk SSR, Institut Problem Materialovedeniia, Kiev, USSR), Inzhenerno-Fizicheskii Zhurnal, V 31:581-586, Oct 1976, A77-14326, In Russian

The effective heat conductivity in direction normal to the fiber plane was determined by a stationary comparison technique for sintered monodisperse wicks prepared of copper, nickel, stainless steel, and Nichrome fibers measuring 20, 30, 40, 50, and 70 microns in diameter. The conductivity is studied as a function of the fiber material, the porosity (ranging from 20 to 96%), and the fiber diameter.

(COPPER, NICKEL, STAINLESS-STEEL, NICHROME)

HP77 41007 INVESTIGATION OF THE THERMOPHYSICAL CHARACTERISTICS OF LOW TEMPERATURE HEAT PIPES WITH METAL-FIBER WICKS

Semena, M.G., Kostornov, A.G., Gershuni, A.N., Zaripov, V.K., Moroz, A.L., (Kievskii Politekhnikskii Institut; Akademiia Nauk USSR, Institut Problem Materialovedeniia, Kiev, USSR), Inzhenerno-Fizicheskii Zhurnal, V 31:449-455, Sept 1976, In Russian

The heat transfer capacity and thermal resistance of heat pipes employing copper-fiber wicks were studied experimentally. It is shown that heat tubes with such wicks are characterized by a low thermal resistance and a high heat-transfer capacity, and that they function satisfactorily at any orientation in a gravitational field.

(COPPER, THERMAL RESISTANCE, GRAVITY)

IV. C. MATERIALS

HP77 42000 THE ELIMINATION OR CONTROL OF MATERIAL PROBLEMS IN WATER HEAT PIPES

Pittinato, G.F., (McDonnell Douglas Astronautics Co.-West, Huntington Beach, CA), 41 p., Oct 31, 1975, MDC-G5481-E, PB-259353/1WE
 Avail:TAC

Several different concepts for utilizing solar energy involve the use of heat pipes to transport energy within the systems. While water appears to be a desirable working fluid in these heat pipes, several studies have shown that a chemical reaction can occur between the water and heat pipe material and thus produce hydrogen gas. The gas is driven to the condenser end of the pipe where it forms an insulating plug which lowers the heat pipe performance. This study is designed to determine the most effective combination of materials, fabrication methods, and operating procedures for a water heat pipe that will provide satisfactory performance when used as a local absorption, solar-thermal energy collector. The heat pipe life tests for the various candidate materials were continued. All of the pipes are maintaining a constant performance level. In order to determine if the wall thickness of a water heat pipe affects its performance curve, one heavy walled heat pipe was fabricated from each candidate material. The performance recovery rate for the heavy walled heat pipes was slower than

that for the thin walled pipes, thus supporting a diffusion dependent recovery mechanism. Two 316 SS heat pipes were fabricated with Inconel 600 condenser end caps. These pipes were found to be self-venting with respect to hydrogen gas.

(SOLAR ENERGY, CHEMICAL-REACTION, LIFE-TEST, 316-STAINLESS-STEEL, INCONEL-600, HYDROGEN-GAS)

V. TESTING AND OPERATION

HP77 50000 THEORETICAL AND EXPERIMENTAL INVESTIGATION OF TWO-COMPONENT HEAT PIPES

Brommer, H.J., (Inst. Kernenerg., Univ. of Stuttgart, Stuttgart, West Germany), Progress in Astronautics and Aeronautics, V 39:145-165, 1975

Avail:TAC

The temperature and concentration distributions within 2-component heat pipes and the extent of separation of components were investigated. Experiments carried out with H₂O-MeOH heat pipes of the 6-artery type confirmed the theoretical results that only a partial separation of the components will occur. H₂O-MeOH heat pipes can be operated at high power levels (>300 W with a heat pipe 500 mm long and 13.5 mm diameter). Two-component heat pipes have a superior cold-startup behavior as compared to 1-component heat pipes, but their axial temperature drop during nominal operation is considerably higher.

(ARTERY, STARTUP)

HP77 50001 EVAPORATIVE HEAT TRANSFER OF LIQUID POTASSIUM IN POROUS MEDIA

Davis, W.R., Ferrell, J.K., (Westvaco Corp., North Charleston, SC), Progress in Astronautics and Aeronautics, V 39:187-199, 1975

Avail:TAC

An investigation of the vaporization heat transfer of K and water in 2 sintered stainless steel wicking materials, FM 1308 and Lamipore 7.4, has shown that for water the vaporization takes place within the porous medium near the heated surface, whereas for K the heat is conducted across the entire wick, and the vaporization occurs at the surface of the wick. The critical heat flux for the K heat pipe can be predicted for all values of the heat flux, whereas for the water heat pipe the critical heat flux can be predicted only for values <40,000 Btu/ft²hr.

(WICK MATERIALS, HEAT FLUX)

HP77 50002 SOME RESULTS OF STUDYING LOW-TEMPERATURE HEAT PIPES OPERATING AGAINST A GRAVITATIONAL FIELD

Gerasimov, Yu.F., Maidanik, Yu.F., Dolgirev, Yu.E., Kiseev, V.M., Filippov, G.A., Starikov, L.G., (Ural. Politekh. Inst. im. Kirova, Sverdlovsk, USSR), Inzhenerno-Fizicheskii Zhurnal, V 30:581-586, N4, 1976, In Russian

Water and Me₂CO heat pipes with separated vapor and liquid channels were studied. The main consideration is given to the type where the wick is located in the evaporation chamber only. The heat pipes have low hydraulic resistance and operate at any orientation on the gravitational field. Construction details of several devices and experimental dependencies of the evaporation chamber temperature on the transported heat flux are presented.

(CHANNELS, HYDRAULIC-RESISTANCE, GRAVITY, HEAT-FLUX)

HP77 50003 TWO-COMPONENT HEAT PIPE

Grakovich, L.P., Pylilo, L.E., From Ref. Zh. Teploenerg., Abstract N. 6G93, 1976, In Russian
No Abstract Available

HP77 50004 SOME FEATURES OF START-UP OF ALKALI METAL HEAT PIPES

Ivanovsky, M.N., Sorokin, V.P., Subbotin, V.I., Yagodka, I.V., Tchulkov, B.A., (Institute of Physics and Power Engineering, Obninsk, USSR), paper No. C7, presented at the 2nd International Heat Pipe Conference at Bologna, Italy, Mar 31-Apr 2, 1976

Avail:TAC

To provide a high heat transfer in heat pipes the so-called complex wicks are used. The required condition for the realization of the possibilities of these heat pipes is a complete filling of wick channels with liquid. An incomplete filling or the formation of steady vapor (vapor-and-gas) bubbles under the screens results in the loss of heat pipe working capacity. Below, taking as an example the experiments with the sodium heat pipes one analyzes the starting features connected both with an incomplete filling of complex wicks and the formation of some bubbles there. The influence of gas availability in a pipe on the working ability of the capillary structures of the stated type is considered here.

(COMPLEX-WICKS, BUBBLES)

HP77 50005 PERFORMANCE TESTS OF GRAVITY-ASSIST HEAT PIPES WITH SCREEN-WICK STRUCTURES

Kempe, J.E., Deverall, J.E., Keddy, E.S., Phillips, J.R., Ranken, W.A., (Los Alamos Scientific Laboratory, Los Alamos, NM), Progress in Astronautics and Aeronautics, V 39:201-213, 1975

Avail:TAC

A series of performance limit tests were made at several operating temperatures with Na heat pipes containing layers of woven-wire screen as wicks. The pipes were tested horizontally and then vertically in a gravity-assist mode with the evaporator down. Higher heat-transfer limits were achieved in the vertical tests, but good agreement between measured and calculated limits was not always obtained. Wick imperfections, in the form of spaces between screen layers and other large openings, were beneficial during horizontal operation because they provided low-impedance flow paths for liquid return. During vertical operation, however, the openings filled with vapor and sometimes produced superheat limitations which seriously reduced heat transfer. In some tests, superheat limitations were eliminated by locating fine-mesh screen between the wick and heat-pipe wall. These tests showed that gravity-assist performance can be improved by large wick passages which are located away from the heat-pipe wall, but the passages must be arranged to collect condensate readily and protect this condensate from the flowing vapor.

(SODIUM, SUPERHEAT-LIMITATIONS)

HP77 50006 DEVELOPMENT OF A BLOCKING ORIFICE THERMAL DIODE HEAT PIPE

Kosson, R.L., Quadrini, J.A., Kirkpatrick, J., (Grumman Aerospace Corp., Bethpage, NY), Progress in Astronautics and Aeronautics, V 39:245-258, 1975
 Avail:TAC

A geometry is described for low-temperature diode heat pipes, in which excess liquid blocks the vapor space of the evaporator and part of the transport section during reverse-mode conditions. An orifice plate is placed in the pipe at the blocking meniscus location, with the opening arranged to permit proper liquid distribution in both ground tests and under zero gravitation. Parametric analysis results are presented for Freon 14, CH₄, and C₂H₆. Experimental data are presented for a room-temperature diode, verifying feasibility, and a cryogenic diode (outside diameter 0.25 in.) with CH₄ working fluid.

(GRAVITY)

HP77 50007 WETTING AND SURFACE PROPERTIES OF REFRIGERANTS TO BE USED IN HEAT PIPES

Reale, F., Cannaviello, M., (Istituto di Fisica Tecnica, University of Napoli, Italy), paper No. G2, presented at the 2nd International Heat Pipe Conference at Bologna, Italy, Mar 31-Apr 2, 1976
 Avail:TAC

This paper presents a simple and still accurate method of measuring surface properties of fluids, such as surface tension, and other related quantities, such as contact angles of fluids to solid walls for some organic coolants, R-11, 12, 21, 22, 114 and 502.

(MEASUREMENT-METHODS, SURFACE-TENSION, CONTACT-ANGLE)

HP77 50008 PARAMETRIC PERFORMANCE OF EXTRUDED AXIAL GROOVED HEAT PIPES FROM 100° TO 300°K

Schlitt, K.R., Brennan, P.J., Kirkpatrick, J.P., (Ames Research Center, NASA, Moffett Field, CA), Progress in Astronautics and Aeronautics, V 39:215-234, 1975
 Avail:TAC

Extensive performance data derived from tests with an Al, axial-grooved, extruded, heat pipe are presented for O, CH₄, C₂H₆, and NH₃, as working fluids. The effects of operating temperature, fluid inventory, heat flux, and elevation on the transport capability and the evaporator and condenser film coefficients are measured and compared to theory. The data correlation indicates that, in addition to the viscous pressure drop of the fluid, a vapor-induced liquid pressure drop must be taken into account at temperatures near or below the normal boiling point. CH₄, C₂H₆, and NH₃ are suitable working fluids for this groove geometry; however, O, because of its low static height, is at best marginal in the 100°-120°K range. The performance in the extruded pipe is better than in a cold-forged pipe.

(OPERATING-TEMPERATURE, FLUID-INVENTORY, HEAT-FLUX, GRAVITY, FILM-COEFFICIENTS)

HP77 50009 EXPERIMENTAL DETERMINATION OF EVAPORATIVE HEAT TRANSFER COEFFICIENTS ON HORIZONTAL, THREADED TUBES

Schultz, V.N., Edwards, D.K., Catton, I., (Energy and Kinetics Dept., UCLA, Los Angeles, CA), paper No. 17, American Institute of Chemical Engineers, 16th National Heat Transfer Conference, St. Louis, MO, Aug 8-11, 1976
 Avail:TAC

Water was evaporated from the outside of 3/4 inch (19.05 mm) brass tubing cut with 10 or 16 American Standard Threads per inch. Preheated feed water was supplied at both sides of the top of the horizontal tube. A stack of tubes 5 deep was tested as well as single tubes. Temperature difference ΔT ranged from 10°C (1.8°F) to 6°C (10.8°F), and heat flow Q from 190 to 290 watts over a 3.00 inch (76.4 mm) long test section. With 2 menisci per thread, heat flow per unit length of meniscus Q/L thus ranged from 33 to 50 w/m for the 16 NF thread and 52 to 80 w/m for the 10 NC one. Thread-side heat transfer coefficient h was found to be highly sensitive to ΔT ; or, put more descriptively, Q/L was surprisingly insensitive to ΔT . At $\Delta T = 3.5$ C (6.3°F) values of h were 18.7 kw/m²°C (3300 Btu/hr ft²°F) and 12.5 kw/m²°C

(2200 Btu/hr ft² F) for the fine and coarse threads respectively. The heat transfer coefficient was found to be insensitive to evaporation-to-feed ratio m_e/m_f in marked contrast to the behavior for plain tubes.

(WATER, HEAT-TRANSFER-COEFFICIENT)

HP77 50010 EXPERIMENTAL STUDY OF HEAT AND MASS TRANSFER IN A CRYOGENIC HEAT PIPE

Vasiliev, L.L., (Inst. of Heat and Mass Transfer, Acad. of Science, Minsk, USSR), Kiselev, V.G., Litvinets, M.A., Savchenko, A.V., Journal of Engineering Physics, V 28:19-21, N1, Jan 1975

Avail:TAC

Experiments were performed to determine the maximum thermal power transported by a cryogenic heat pipe with a nitrogen working fluid and a wick made of sintered bronze powder. It is concluded that heat pipes with wicks made of sintered bronze powder are of interest for operation in the region of cryogenic temperatures, since they can transport large thermal fluxes in a horizontal direction in the presence of small temperature drops.

(MAXIMUM-POWER, NITROGEN, SINTERED-BRONZE-POWDER)

HP77 50011 INVESTIGATIONS OF NONSTEADY-STATE PROCESSES AT CRYOGENIC HEAT PIPE OPERATION

Ivanovsky, M.I., Illyin, Yu.A., Korneev, V.I., Privesentsev, V.V., Serbin, V.I., Sergeev, Yu.Yu., Sidorenko, E.M., Sorokin, V.P., (Institute of Physics and Power Engineering, Obninsk, USSR), paper No. D1, presented at the 2nd International Heat Pipe Conference at Bologna, Italy, Mar 31-Apr 2, 1976

Avail:TAC

In the report two problems have been treated experimentally and theoretically, i.e., dynamics of filling the capillary structure of heat pipes with fluid after drying out and capillary limitations for heat transfer under non-steady thermal conditions. The experiments were performed on heat pipes with ammonia and freon-22.

(THEORIES, EXPERIMENTS, DRYOUT, WICKING-LIMIT, AMMONIA, FREON-22)

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